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Report:
Learning in the Construction Industry Literature Review

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Learning in the Construction Industry

Literature Review

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Background

Innovation is widely accepted as the key to better productivity, performance and profitability across many industries, including the construction arena (Powell, Koput and Smith-Doer 1996, Winch 1998, Siriwardena and Kagioglou 2005). Innovation refers to "…the actual use of nontrivial change and improvement in a process, product or system that is novel to the institution developing the change" (Freeman 1989). In essence then, innovation refers to the implementation of new ideas, processes, and technologies to enhance the competitiveness of a firm or industry. Many analysts consider there is a need for more innovation within the construction and building arena (Slaughter, 1998; Winch, 1998; Hampson and Manley, 2001). On the importance of innovation to the building and construction industry Tatum (1991: 447) has stated:

> At the bottom line, engineering and construction firms need to innovate to win projects and to improve the financial results of these projects. They must innovate to compete. Development and effective use of new technology can provide important competitive advantages for engineering and construction firms. These advantages stem from distinctive technical capacity, improvements in operations, and an image as a technically progressive company.

For many theorists the key to effective innovation practice and products is through an increased emphasis on learning since learning helps the firm develop structures and systems that allow it to adapt to changing circumstances (de Gues 1997, Senge 1990, Kanter 1983, 1989).

Learning as a conduit to innovation is increasingly understood to occur through a highly interactive and iterative process that cuts across internal and external organisational boundaries. Despite the increased emphasis in the literature and practice on learning and innovation, little is known about how innovation through learning and knowledge sharing occurs or becomes embedded within an innovation system (Gieskes and van der Heijden 2004). More specifically, since as Spekman et al (2002) note, firms vary in their ability to learn and adapt, there is a need to better understand the idiosyncratic learning behaviour of different types of innovative organisations in order to leverage from and accelerate innovative outcomes. This identified lack of systematic empirical research on learning behaviour of innovative organisations (Easterby-Smith 1997, Gieskes and van der Heijden 2004) is especially problematic in the building and construction arena where there is an economic, political and social imperative for increased innovation (Tjandra and Tan 2002).

As part of its charter to increase innovation quantity and quality in the construction industry, the BRITE Project will undertake a study to distil the key learning behaviours of innovative organisations. In doing so, it will be extending its existing research findings based on an innovation survey undertaken in 2004 (Manley, 2005), as well as on a suite of innovation case studies conducted between the years 2003-2005 (Manley and Blayse 2003; Manley, Hardy and Keast 2005). This new program of work looking at learning behaviours is the result of knowledge gaps identified by this early work.

The purpose of this working paper is to:

- Provide a literature review that distils the key components, systems and processes of learning within highly innovative organisations and systems; and
- Establish an analytical framework to guide the development of a research focus and question set.

The Context for Innovation and Learning

According to scholars and practitioners across a range of fields of inquiry and endeavour, contemporary organisations in industrialised economies are confronted with an increasingly globalised market, rapid and continuous technological developments, as well as changing societal norms, values and expectations (Keating 2000, Beresford 2000, Davis and Brady 2000).

The construction sector, although often portrayed as an insulated and slow to change industry, has not been exempt from these broad pressures for change. For example, increasing demands for more functional and environmentally appropriate buildings, and the availability of increasingly sophisticated technology and equipment, coupled with national and international comparison and accelerated competition have been identified as forcing the sector to adopt new processes and mechanisms (Tjandra and Tan 2002, Manseau and Seadon 2001; Dewick and Miozzo 2004). Winch (1998) has also pointed to the expansion of the competition base and market to include Pacific Rim stakeholders and markets and the increased demand for environmentally appropriate construction options as contributing to the level of change and uncertainty within the sector.

Indeed, broader international, social and environmental stances and policies have a big impact on the nature and operation of the sector (Cooper 1997; Hampson and Manley 2001; Dewick and Miozzo 2004). The influence of cross-jurisdictional or global policies, have been highlighted in several case studies within the BRITE series, for example, manifested in demands for more energy efficient and environmentally sustainable buildings and building processes.

Further, increasing demands for greater input and direction setting by stakeholders such as tenants, clients and equipment manufacturers that have conventionally played more peripheral roles have added to the need for change within the construction arena (Manseau and Shields 2005). Although, as Nam and Tatum (1992:507, 1997) and others (Ivory 2005) qualify, because of their limited industry knowledge and lack of collective influence, domestic clients are not generally high demanders for innovative product, processes and outcomes.

The fragmented nature of the construction industry (Winch, 1998; Kale and Arditi, 1998; Hampson and Manley 2001) and its highly project based operational orientation (Manseau and Seadon 2001; Dewick and Miozzo 2004) hamper the industry responding effectively to the forces for change. These structural features of

the industry are argued to act both as a driver for more organisational learning and as an inhibitor.

This is unfortunate, as the almost universal response by analysts globally, to retain and improve competitiveness and productivity within such rapidly changing conditions and the resulting high level of technical and market uncertainty, has been calls for learning and innovation. Dodgson (1993) has stated: “The greater the level of uncertainly the greater is the need for learning”. That is, in order to survive and prosper, organisations and industries must respond to social, economic and political change and adjust their operating behaviours and structures accordingly (de Geus, 1988; Senge, 1990). Putting the case for innovation through learning from, and adaptation to, environmental forces more firmly, de Gues has observed: ”The ability to learn faster than your competitors may be the only sustainable competitive advantage” (cited Senge (1992:4)). Howard (2005), in his review of innovation processes in Australia, highlighted the continuing currency of learning to grow competitive advantage: “The best organisational design is adaptive, self-correcting and robust over time”.

In responding to the increased uncertainty and turbulence brought about by rapidly changing markets, expanded competition and technological developments, the construction sector has sought to capitalise on and leverage from the opportunities of change. Consequently the notions of organisational learning and the learning organisation have become key strategies in promoting competitive advantage at firm-level and in overcoming the industry’s structural challenges (Lansley, 1987; Tjandra and Tan, 2002; Anheim, 2003).

Organisational Learning and Learning Organisations

The notion of organisational learning can be traced to the early 1960s, through the work of Cyert and March (1963) and Cangelosi and Dill (1965) and subsequently Argyris (1977) and Argyris and Schon (1978). Cyert and March (1963) viewed organisational learning as an adaptive process where organisational aspects such as goals, rules and actions were modified by the experiences of the organisation. Similarly for Argyris (1977) organisational learning was conceived as the process of “… detection and correction of errors”. Nevis et al (1995) described organisational learning as the capacity or processes within an organization that allow it to improve its performance based on experience. For McGill et al (1990) the need for a willingness to examine both success and failure was an additional characteristic of a learning organisation. Thus, as Senge (1992:142) states: “Learning in this context does not mean just acquiring more information, but expanding the ability to produce the results that we truly want from life”. The central argument of these and related literature is that organisational learning can be a powerful tool to promote innovation and improve the performance of an organisation.

It is the view of many theorists that since organisations cannot themselves learn; they rely on individuals to act as learning agents (Argyris, 1977; Hedberg, 1981). In this way, organisations learn via the individuals within the organisation, their interactions, events and colleagues both internal and external (Argyris and Schon, 1996; Senge, 1992). However, as Simon (1991) proposed, complete rationality of action requires a complete knowledge of all the relevant information. The human brain, despite its conceptual and computational power is restricted in its learning capacity by an inability to respond to all stimuli. Moreover, the effectiveness of organisational learning can be impeded by personal insights and experiences of individuals that differ from or even are opposed to the broader organisational learning agenda.

Learning Organisation

It is argued that the learning capacity of individuals can be facilitated or inhibited by organisational and environmental factors (Argyris, 1977; Senge, 1990). This notion of organising for learning or adjusting structures and processes to 'ramp up' learning capacity are considered to be a basic characteristic of the 'learning organisation'. Senge (1990) defines the learning organisation concept as the organisation "… in which you cannot *not* learn because learning is so insinuated into the fabric of life". As well as embedding cyclical learning processes within the organisation, organisational learning can be facilitated by more concrete managerial and institutional processes and systems (Senge, 1990, 1992; Salaman, 1995; Pitts and Lei, 1999).

For a number of authors (eg. Senge, 1992), increasing adaptiveness represents only the first phase in moving toward a learning organisational model. Increasingly it is argued that organisations must move beyond adaptation to adopt a generative, more proactive, self-actualised approach that enables the organisation to move into new products, markets and regimes. Thus, generative learning, requires a new way of looking at issues, is more holistic, lateral and reflective.

The distinction between adaptive and generative learning is based on the theoretical work of Argyris and Schon (1978; 1996) and the concepts of single, double and multi-loop learning (Argyris, 1991). Single loop learning is adaptive and refers to the ability to respond to change in specific sets of circumstances, and is usually associated with incremental change. Double and multi- loop learning is generative and by contrast is more complex, involving the ability for individuals to reflect upon their experiences, learn, reconceptualise and apply to other contexts. Argyris and Schon (1996: xix) comment on this:

> Organizational success, however defined, is seen as depending on the organization's ability to see things in new ways, gain new understandings, and produce new patterns of behaviour – all on a continuing basis and in a way that engages the organization as a whole.

Current literature on organisational learning has focused on continuous improvement as the driver for new knowledge and learning (Scarborough et al 1992; Wang and Ahmed, 2003). As an example, Total Quality Management (TQM) with its emphasis on continuous improvement is argued to reflect the evolution from adaptive to generative learning (Senge, 1990). The apparent failure of TQM as a performance improvement instrument within the construction sector (Abdul-Aziz, 2002; Haupt and Whiteman, 2004; Karim, Marosszeky and Kumaraswamy, 2005) suggests that learning loops can be inhibited and or disrupted by cultural and other organisational barriers.

Nevertheless, a main principle of the learning organisation is that the learnings generated by the sum of the individuals within an organisation are greater than that able to be achieved alone by individuals within it. This reflects the old adage regarding the sum of the parts being greater than the individual components. Thus the nexus between the individuals is central to the greater success of a learning organisation and how individuals within organisations interact is crucial. This perspective encapsulates the multiplier effect posited within systems theory (Checkland, 1981). That is, by integrating learning from other disciplines and units, "the whole can excess the sum of its parts" (Senge, 1992: 12). The establishment of a 'learning organisation' then is based on multiple vertical and horizontal interactions

and communications inside and across the borders of the firm. Reflecting this variety of interactions, most conceptual frameworks for organisational learning incorporate at least four different analytical levels for learning: the individual, the group or interpersonal level, the organisational level and the inter-organisational or networking level of learning (Pawlowsky, 2001).

More recently, the notion and context of a learning organisation has been extended to a learning economy (for example, Nielson and Lundvall, 2003). Such an economy offers greater growth potential than traditional economies that rely on the more intensive use of knowledge and other resources to fuel growth. Whereas, in more modern learning economies knowledge becomes obsolete more rapidly, making it imperative that firms engage in organisational learning and that workers constantly attain new competencies to fuel growth.

Networks

The conventional process for fostering organisational learning and innovation was based primarily on individual behaviour and linear models (Weick, 1990; Bureau of Industry Development, 1991). This approach is exemplified by the 'brilliant individual' or single agency working alone, specialised publicly funded research institutions, or limited and contested higher education funding and internal industry Research and Development (R&D) Units, where learning flows are a more structured or directed mode of knowledge sharing and idea development. However, as a number of theorists (Lundvall, 1988; von Hippel, 1988) have indicated, these old 'go it alone' models are increasingly the exception rather than the norm.

This shift in innovation and learning models is based on an increasing understanding that learning and therefore innovation occurs through a highly interactive and iterative approach (Weick, 1990; Cooke, 1998). The Bureau of Industry Economics explains the rationale for this shift in approach to achieving innovation:

> For some time, studies of innovation processes have stressed the importance of networks to successful innovation, over-turning the traditional model which characterises innovation as a linear sequence running from basic research, through product development, to production and marketing. Innovation is now seen as an interactive process requiring intense traffic in facts, ideas and reputational information within and beyond the firm (1991: 7).

With an emphasis on interpersonal relationships, trust and reciprocity between actors as the conduit for more effective information and knowledge sharing, network forms of organising are widely perceived as creating the most conducive environment for producing and diffusing innovation within a number of sectors including the building and construction arena (Powell et al 1996, Cooke 1998, Swan et al 2003). In the network model knowledge is not directly transferred but continuously created and recreated through networking interactions as individuals come to share a common understanding or frame of reference. From this perspective networking is not a case of linear information transfer but a process of interrelated sense making (Weick, 1990).

Through enhanced relationships and shared understandings, learning behaviour is maximised, leveraged and applied to produce new and novel results. Huxham (1996) refers to this 'spill over' or multiplier effect of interaction as the process of collaborative advantage.

A growing body of research across a number of construction sectors has demonstrated that successful innovation is increasingly perceived to be the result of closer relationships and learning between individuals, firms and even sectors within the construction industry (Walker and Hampson 2003, Miozzo 2002, Miozzo and Dewick 2004, Manseau and Seadon 2001, Manseau and Shields 2005). Miozzo and Dewick (2004) provide the justification for stronger inter-organisational cooperation:

> In a complex systems industry such as construction, firms must rely on the capabilities of other firms to produce innovations and this is facilitated by some degree of continuing cooperation between those concerned with the development of products, processes and designs.

Case studies by Landry and Amara (1998:274) provide further evidence that 'innovative firms develop more interactions with outside sources of ideas, information and technology than non-innovative firms do'. Recent research by the BRITE Project in the Australian construction industry context supports this view, with high-level innovators adopting nearly eight times as many advanced practices from external sources than low innovators, indicating a much higher level of interaction with external agents (Manley 2005:75).

A consequence of this emphasis on team effort between a collective of industry players and stronger industry relationships has been the development of many new forms of inter-firm arrangements and procurement models, including partnerships, collaborations and alliances in the construction industry (Anderson and Manseau 1999, Manley and Hampson 2000, Miozzo 2002, Miozzo and Dewick 2004, Dubois and Gadde 2002, Walker and Hampson 2003). While these models vary significantly in their operation and intent, all share a common underpinning of a more collective and relational approach to construction outcomes and look to capitalise on and leverage from the collective learning available within these new structures to maximise competitive advantage for businesses and deliver better project outcomes (Thompson and Sanders 1998).

Network Connections

The above section has highlighted the emergent literature's emphasis on the importance of interpersonal connections within and between organisations as a conduit for learning and innovation (Swan et al, 1999). However, as Considine (2002:4) attests, the network concept conceals a multitude of connections and actions. The most basic of these is the difference between internal and external connections. Internal networking is necessary to convince others within organisations of the potential advantages of new technology and to bring together the necessary skills and knowledge required to implement and leverage from emergent ideas. Knowing and understanding the roles and projects of other employees or work units, as well as their potential and the issues that may confront them, can be an important first step for innovation, providing the basis for future idea leverage (Powell et al, 1996). On the other hand, external network connections act as conduits for accessing new and novel information and may generate incubators for cross-firm/sector learning and innovation (Powell et al, 1996).

Either type of network may contain 'champions' with passion for particular projects or ideas and the ability to attract others to the cause. Such champions have frequently been identified as an important node in both internal and external network connections (Rogers 1983, Tatum 1991). Working within and across organisational boundaries, champions can act as conduits for information and, importantly,

demonstrate or model the collaborative behaviour necessary for innovation (Mandell and Steelman 2003, Nam and Tatum 1997). The strategic role of a 'network sponsor' has also been identified within the broader network management literature as critical to linking horizontal networking activity to the vertical axis of power and authority (Keast et al, 2004). As Bryson (1995) noted, the presence of a powerful sponsor helps to generate resources and support and provides legitimacy to horizontal or internal networks.

The enormity of possible external network connection/contacts has been generally accommodated under the two groupings of vertical or supply chain networks and horizontal, system network connections (Porter, 1990, 1998; Manley, 2003), although there is considerable overlap in terms of positioning for various theorists/authors.

Supply Chain networks refer to the set of organisations that are necessary to complete a project, or bring a product to market. In the construction context, this has conventionally included manufacturing and equipment suppliers, but could be extended to comprise architects, contractors, and clients (Dewick and Miozzo, 2004). Manley (2003: 13) refers to this chain as the "vertical spine of critical inter-firm relationships'. Clients are a more recent inclusion in the vertical/supply network and, if well informed and integrated into the system can contribute to the learning process and outcomes through the introduction of new, novel ideas and directions. Studies of highly successful and profitable firms indicate very close ties to the customer base and innovation activity linked to direct market opportunities (Cooper, 1999).

Linked to and underpinning the vertical supply chains are the various arrays of network connections provided by employees. The boundary-spanning activities of individual employees and supply chain members through their involvement in professional and trade associations have been shown to facilitate learning and subsequently the diffusion and adoption of new ideas (Swan et al, 1999). Through such external networking activity individuals become aware of new technologies, new products, and data sources that may be relevant to their organisations. The ties recent graduates often retain with learning institutions are also recognised as an important learning aid for their parent organisations (Manley and McFallan 2005, Rogers 1983; Hansen 1999). Other sources of knowledge and learning include consultants (Bessant and Rush 1995) and membership of professional associations and other informal connections (Conway 1995).

There is a growing body of empirical and theoretical literature that highlights the need for attention to the strength of relationships required for innovation. Specifically it is argued that there is a need for network links and their aggregated structural arrangements to be requisite to their purpose. The seminal work of Grandovetter (1973; 1985) introduced the notion of the 'strength of weak ties' to indicate that weak or loose connections between units provided access to new and novel information not available in closely interrelated networks. Drawing from this it is widely contended that innovation networks, while requiring cohesion and stability in their core relationships, must also have a suite of loose connections to tap into alternative data sources (Hansen 1999; Uzzi 1998).

Expanding the Network Concept

It is apparent from the above sections that innovation processes are becoming more interactive as well as more dependent on knowledge that is widely distributed. In order to exemplify both the expansion of the stakeholders and levels of operation and interaction that now involve learning as well as the accelerated level of interaction that now needs to occur, a number of theorists and authors have conceptualised

these highly interactive and interactive learning processes in terms other than networks. Key examples include the notions of 'innovation system' or 'systems of innovation' (Lundvall, 1992; OECD, 1997; Howard, 2005). These models build on the basic network concept to emphasise the increasing complexity of successful innovation and the importance of external knowledge sources. Lundvall (1992:11) defined innovation systems as a collective of "… organisations, institutions and people that interact in the production and diffusion of new economically useful knowledge". Reflecting this opinion, the OECD has referred to complexity of factors and actors shaping innovation at the firm level as the 'innovation dynamo' (OECD, cited Oslo Manual: 22).

Along a similar line, Gibbons (1994) noted that "models of knowledge production" are changing from a conventional disciplinary based model, to a new mode where knowledge is produced interactively at the point of application among heterogeneous groups. Along a similar line, Leydesdorff and Etzkowitz (1998) have presented the 'Triple Helix' as a model of analysis for innovation that occurs at the intersection of government, university and industry learning. Although operating at a level that does not take into account the daily micro learning actions and activities of scientists, entrepreneurs, industrialists and policy makers, it stresses that interfacing technological innovation is first and foremost an interactive learning process.

Porter's (1990; 1998) work on clusters during the 1990s provides a related but different view of inter-organisational relationships by delineating vertical and horizontal network connections and providing an essentially regional focus. Porter's theory is that firms and regions can leverage off an increasingly specialised and networked environment to create competitive advantage. The focus in this model is on building a supportive and often specialised environment for cluster participants and extending the number and range of linkages between participating firms, their suppliers and related supporting organisations.

In her review of interactive innovation processes, Manley (2003) highlighted the presence of a number of these emergent innovation models including innovation systems, clusters, value-chains and networks and concluded that they represented a shift in the level of intensity as well as a broadening of the scale and scope of interaction. Such a view concurs with that of Lund Vinding (2002) who indicates that recent models of innovation place a greater emphasis on learning and knowledge production and stressed that innovation is an interactive process in which firms relate at a much higher scale with customers, suppliers and knowledge institutions.

Enablers of Organisational Learning for Innovation

Literature from both the learning organisation and management streams, provide an indication that certain organisational characteristics can promote and accelerate learning and innovation. This section provides an overview of the key learning enablers identified from diverse literature sources.

As a starting point for accelerated organisational learning, a number of authors have concentrated on enhancing individual and interpersonal process for learning and development (Bommer and Jalajas, 1999; Utterback 1996). Key interpersonal learning enablers centre on matching individual and group learning styles to organisational processes and systems, and staff development through training and development initiatives such as mobilisation programs (Pitt and Lei, 1999). Leadership that is people and learning centric, and provides opportunities for expanded and extended interaction across units and firms has also been identified as assisting the learning process (Senge, 1990; Salaman, 1995).

The capability to learn also depends on the characteristics of the organisation: the structure of its labour force and facilities (skills, departments), its financial structure, strategy on markets, competitors and alliances with other firms and above all its internal organisation and culture. For many analysts, the existence of a clear and well-articulated vision statement is an important prerequisite to a learning organisation as it provides a common goal or purpose to encourage staff to work together to share information, learn from each other and create (Porter, 1980; Schein, 1992). On the matter of vision, Senge (1990) claims that successful organisational learning is based on team learning and the presence of a *shared* vision. Further the building of shared vision fosters commitment to the organisation and generates the excitement, energy and focus necessary for innovation to transpire. Others, for example Von Hippel (2002) and Amable et al (1997), stress that there must be incentives for knowledge sharing within the organisation.

On the subject of supporting policies and practices provided by organisations to support the learning of individuals, Schein (1992) and others stress the need to build a cultural climate that is able to facilitate change and adaptation. That is, for an organisation to adapt and leverage off learning for innovation, it has to develop an internal climate (culture, orientation and vision) that not only motivates individuals to maximise their own learnings but to collaborate with colleagues. Thus policy, action and institutional processes should encourage learning and nurture interpersonal skills and attributes toward knowledge sharing and collaboration.

Collins (2001) and Goleman (2000) concur with the need for organisational climates capable of facilitating learning and add that this requires a leader with high levels of emotional intelligence, that is the ability to identify, tap into and leverage emotions to facilitate thinking and learning. Similarly Senge (1990) stresses the need for new types of leaders; those with the ability to establish a shared vision, challenge prevailing and limiting mental models and foster systemic thinking. In summary, Senge (1992) stresses that the ability of an organisation to learn depends on its 'learning orientation' (its values and practices that determine where learning takes place) and its 'facilitating' factors (structures and processes) since both these influence how easy it is for learning to occur.

For Pitts and Lei (1999), the critical aspects of learning organisations centre primarily in the interpersonal realm and include strategies such as frequent rotation of managers; continuous training of individuals; decentralisation of decision making; the encouragement of multiple experiments by staff; a high tolerance for failure; and openness within the organisation toward a diversity of viewpoints. While Salaman (1995) identified leadership, open and proactive structure and processes, cognisance of the impact of social and macro operating and environmental contexts, and a culture that supports and rewards learning as necessary prerequisites to the establishment of a learning organisation.

Specifically discussing the construction arena, Tjandra and Tan (2002) identify leadership, group dynamics, employee turnover and routine as important factors that construction companies need to pay attention to in order to foster organisational learning. Santos and Powell (2001) suggest that the creation of an effective learning mood in construction is likely to happen in an environment supported by pull learning, i.e. the exploitation and manipulation by workers of action and ideas 'on the job'. These authors continue that pull learning is facilitated or initiated by 'push learning' that is generated by outside factors.

Another construction industry study, in Australia, surveyed 1,300 businesses in the road/bridge and commercial building sectors. The study sought to better understand the innovation patterns within the industry, determinants and inhibitors for innovation and the strategies and processes employed to achieve innovation. With respect to the latter, the study (Manley 2005) found that compared to organisations assessed as low innovators, high innovators were significantly more likely to:

- actively encourage employees to seek out improvements and share ideas
- recruit new graduates
- engage in inter-industry networking
- monitor international best practice
- transfer project-based learnings into continuous business processes

The study concluded that these business strategies are key drivers of innovation success.

At the same time, recent studies of organisational learning in project-based sectors have identified a set of 'good practice' learning processes (Brander- Lof, Hilger and Andre, 2000; Turner, Keegan and Crawford, 2000). Some of these learning principles include:

- Systematic collection of learning from projects
- Periodic project reviews
- Information management tools to capture, store and retrieve learnings
- Formal management of the knowledge system
- Training and staff support

Scott and Harris (1998) concur with the evidence presented above on the need for systems and processes to facilitate individual and collective learning and its diffusion and action but observe that the development of systems to promote learning is often informal and unstructured. However, there is a growing appreciation of construction projects as structured networks. Anhiem (2003) identified the use of project teams as a successful strategy for facilitating knowledge sharing and learning within and between construction projects.

Technological applications such as advanced information, communication and computer technology (ICT) can greatly assist an organisation's learning and innovation processes. ICT allows organisations to tap into new and rapidly evolving data sources and ideas, as well as open organisations up to, and encourage greater cognisance of, alternative approaches. In order to be innovative, firms must identify what these opportunities are and set up a relevant strategy. This is where ICT can help. However, as a number of authors have pointed out, technological capacity is embedded in its labour force and without skilled workers a firm cannot master the new technologies to produce innovation. Thus, as Howard (2005) stresses while technology is important it needs to be linked to people. Similarly, Lau (1998) has stressed the importance of appropriate technology expertise to derive optimal outcomes from technological equipment.

The existence of R & D activity within firms is generally positively associated with innovative organisations. Again the learning literature stresses that unless R & D activity is linked into knowledge systems it can have only a limited impact on organisational learning (Lau, 1998).

Reviewing Key Empirical Studies of the Manufacturing Industry

In their 2004 study of the manufacturing industry, Gieske and van der Heijden examined learning behaviour by testing the application of eight learning enablers identified from the extant literature: product family strategies, process definitions, HRM policies, project planning and control, performance measurement, design tools and methods and computer based technologies. Using exploratory factor analysis as their principle method of data analysis, Gieske and van der Heijden found that six of the eight enablers appeared to be effective in stimulating learning behaviour. The two failed hypotheses (product family strategies and computer based technology) were considered surprising and the authors have qualified their results indicating that it may in large part be explained by the question construction. The enablers, their components and the results of the study are set out in Table 1, below.

Table 1: Summary of Results: Gieskes and van der Heijden (2004).

Enablers	Specific examples	Results of study
Product family strategies	Product plans, carry-over policies, standardization policies	Not supported, but results inconclusive
Process definition	Stage-gate processes, company innovation procedures	Supported
Integration mechanisms	Teamwork, matrix organisation, and committees	Supported
HRM policies	Personnel rotation, departmental assessment and development plans, reward systems & empowerment programs	Supported
Project planning & control	Project termination reports, design reviews	Supported
Performance measurement	Comparison of measures against previous results or with other subsidiaries or leading organisations	Supported
Design tools & methods	Standardised design methodologies and procedures, libraries of standard design solutions, integration procedures	Supported
Computer based technologies	IT systems, computer-aided technologies, prototyping technologies	Not supported, results inconclusive

Using a similar set of variables, Chapman et al (2000) found that computer technology and project planning activities supported organisational learning in small organisations (less than 30 staff) particularly in customised product niches.

In a slightly earlier study, Nielson and Lundvall (2003), drawing on a data set of 2000 Danish private firms, demonstrated that firms combining several of the organisational traits of a learning organisation are more prone to introduce new products than others. Specifically Nielson and Lundvall (2003) found that when organisational characteristics relating to integrated organisation, such as quality management, human resource development, compensation systems and external network positioning were combined there was strong impact on knowledge creation in terms of product innovation. This study also demonstrated that innovative firms involved employees in different forms of direct and indirect participation more frequently than other firms. These authors concluded that those organisations that combine several of these characteristics tend to introduce product innovation.

Although focused on the manufacturing arena the findings in this section provide some general insights into the types of activities and processes that can stimulate learning in the construction industry.

Putting it All Together: Synthesising Learning Behaviour Characteristics for Innovation

This review has demonstrated that there is a wide array of behaviours, processes and mechanisms that can be employed by businesses to facilitate accelerated learning and innovation. Although clearly interrelated and often intersecting, these sources of learning can be split into three domains – organisational context, organisational characteristics, and organisational connections.

Organisational Context: Optimal learning is achieved when organisations have a strong and strategic external focus that allows them to identify, interpret and anticipate (rather than react) changing economic, social, environmental and political conditions in their environment. This proactive attendance to external conditions will be facilitated by internal processes and systems such as research or strategy units that monitor environmental shifts including government policy reviews and adjustments and are attuned to best practice developments within the sector. Further, successful learning organisations are cognisant of their industry structure as well as economic and construction cycles, and use this information as a basis for strategic positioning and development.

Organisational Characteristics: The people within organisations have been identified as a key source of organisational learning. Within this broad category, a number of subgroups including project and knowledge workers, administrative and support workers and management have been isolated as being repositories and developers of various types of information to aid learning and performance. The nature of business structure and processes has also been shown to be critical. Social infrastructure mechanisms are also important, such as pro-learning policy and culture, well articulated missions and strategic direction, coupled with a proactive communication system with sufficient broadband to facilitate and diffuse knowledge and learning.

Organisational Connections: The opportunity for learning is maximised when the organisation is cognisant of the need to establish and maintain both internal and external network connections/relationships and provide necessary resources, processes and mechanisms to direct, facilitate and leverage from these multiple knowledge sources. The most successful learning will be achieved through relationships and linkages that are not just present but highly interactive, dynamic and vigorous. However, for optimal learning, these connections must be strategically monitored and calibrated (configured and reconfigured) in terms of their types of linkage and strength of relationship according to changing requirements.

Figure 1, below summarises the primary sources of business learning in each of these learning domains

Figure 1: Key Sources of Business Learning

Context	**Characteristics**	**Connections**
o Industry	o Staff	**Supply Chain** (vertical connections) (tight

structure o Economic cycles o Construction cycles o Political factors o Social values o Government policy	o Business Structure o Business Systems o Social infrastructure (culture, values, mission) o Leadership qualities	links for project-based work) o Clients/Customers o Contractors o Consultants o Manufacturers/Suppliers **Systems Web** (vertical and horizontal Connections) (loose links for information and innovation ideas) o Professional associations o Academic & research institutions o Monitoring Bodies o Regulators

Source: The Author

This review has demonstrated that the construction arena is confronted by an array of social, economic, political and environmental factors that require a greater orientation toward the development of new, more innovative ways of working. As these pressures have intensified in recent years, organisational and inter-organisational learning has increasingly come to the fore in facilitating appropriate responses. Also revealed in the literature review is a set of sources through which learning might occur. How these learning sources interact to offer optimal learning opportunities remains an under-examined topic within the construction industry.

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